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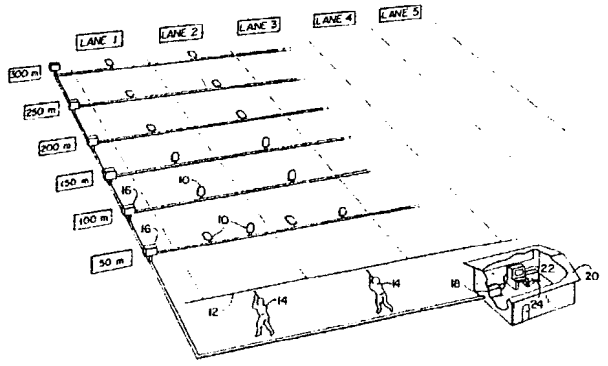
(54) Target range status indicator and controller.

(57) Disclosed is an apparatus for indicating on a video display unit (22) the status of a plurality of targets (10) on a target range system and for controlling the operation thereof. In a preferred embodiment, the video display unit (22) comprises a variable image display unit which can be a cathode ray tube (CRT) which is responsive to a computer processing unit (CPU) (40) which sequentially and periodically interrogates each target mechanism (38) to determine its functional status and whether it has been «hit». This information can be displayed in many different formats although in a preferred empodiment, a number of banks und lanes of targets are provided on the CRT which correspond to the banks and lanes of targets as laid out on the range. Further, the total hits for all targets in each lane are displayed on the screen along with a fault indication if necessary. Substantial improvements and the reliability and maintainability of target range control systems are achieved by the use of the CRT-equipped video display unit (22) in combination with the CPU (40). In further preferred embodiments, all targets in an individual bank provide information to a field equipment module (FEM) (16) for that bank which then provides the information to a computer peripheral device (30) which converts the information to a form usable by the CPU. Additionally, the range may be controlled in a manual, automatic or semiautomatic mode and target status information along with lane scores provided in a permanent manner by means of a peripheral printer (42).



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TARGET RANGE STATUS INDICATOR AND CONTROLLER

BACKGROUND OF THE INVENTION

The present invention relates generally to machine status indicators and controllers and specifically to target range status indicators and controllers.

In order to meet the needs of a modern military force and the need to quickly and professionally train soldiers, police officers, etc., in the proper use of small arms weaponry, it is common to provide target ranges which are remotely controlled to at least some degree. Typically, the ranges will have a plurality of lanes, one for each marksman, and in the lanes there may be a plurality of targets located at different distances from the firing line behind which the marksman is located.

In a remotely controlled range, it is desirable to be able to control the operation, lighting, etc., of the targets such that different targets can be raised and lowered to provide a variety of target changes to the marksman. Each target then may have a raising and lowering mechanism which is responsive to controls located at some distance from the firing line, preferably in a control building of some sort. It is further desirable to accumulate scores indicating the number of times a target has been hit and relate these scores to the marksmen in their respective lanes. Furthermore, the status of each target, whether raised or lowered, illuminated, etc., in addition to fault identification, is useful information to the Range Control Officer who may be located in the control building.

In the past, ranges were controlled by specialized panels or consoles which utilized a plurality of switches to provide control outputs to the targets and a plurality of lamps and/or digital displays for indicating the status and/or scores relating to each target. It can be seen that where there are a large number of lanes (for example 16) and each lane has a plurality of targets therein at different distances (for example 7) the resultant number of lamps and digital displays to provide target up/down, fault and/or hit information is relatively large (112 indicators for each item of information). In the past, these indicators have been located on a specialized panel or console in some logical arrangement corresponding to the arrangement of targets on the target range. Obviously, the wiring of such a console or panel is very

time-consuming and requires extreme care on the part of the manufacturer. Additionally, with such a complex wiring arrangement, after manufacture, the device is very expensive to maintain and is subject to a high number of lamp and/or digital display failures simply due to the number involved in the panel. These failures require the Range Control Officer either to operate under the handicap of not knowing necessary information or requires that the range be shut down for substantial periods of time for the required maintenance.

If a display dimmer is included, in order to avoid destruction of the night vision of the Range Control Officer or other personnel in the control building, this merely adds to the cost of wiring the panel or console in the first place.

An example of such a hard wired fixed mode control panel and display indicator is shown in Figure 13 of U.S. Patent 4,222,564 entitled "Automated Scoring Target System" by Allen et al. In view of this panel's complexity, it is desirable to provide target range status indicator and control system which does not have the above-noted reliability and maintainability deficiencies.

As can be seen in this patent, in order to add a new status or target information indicator, it would require extensive revision of such a hard wired display panel which, in most instances, would require that a whole new panel be designed and built at tremendous expense.

SUMMARY OF THE INVENTION

In view of the above and other prior art problems, it is an object of the present invention to provide a target range status indicator in which target status and hit information is provided to the range control officer on at least one computer-driven video display unit (VDU).

It is a further object of the present invention to provide a range status indicator which interrogates all targets on the range and continually updates the display provided to the range control operator.

It is a further object of the present invention to provide a video display unit which is driven by a digital processor which can be programmed to display the hit indications at each individual target, the hit indications accountable for each lane of targets and the position status information of each target on the range.

It is a further object of the present invention to provide a computer driven target range status indicator and controller which can either manually or automatically control the position status of targets either individually, by banks of targets, by lanes of targets or by other target groupings and indicate the control functions on a video display unit.

It is a still further object of the present invention to reduce the reliability defects and the

maintainability expense of prior art target range control systems by utilizing a cathode ray tube video display unit to indicate not only target position status but target hit and lane score information as well.

It is an additional object of the present invention to utilize a video display unit in the form of at least one variable image display unit which in one embodiment is a cathode ray tube whose brightness and/or contrast can easily be adjusted such that the Range Control Officer's night vision is not adversely affected by virtue of his monitoring the range status.

The above and other objects are achieved in accordance with the present invention by programming a processor to interrogate a plurality of target condition sensors located at each target in a sequential manner and to apply the information achieved through interrogation to a video display unit. The same processor is also utilized in preferred embodiments to adjust the position status, lighting conditions, and implement any visual and/or audio retaliation effects for each target in a manual, semiautomatic, or fully pre-programmed automatic manner. Thus, different training programs can be pre-programmed to provide the optimum training benefit for a "raw" recruit or for a skilled marksman undergoing a refresher course. The present invention not only permits fault indication on the cathode ray tube display but also permits any additional function or status information which is available at some time in the future by a simple

reprogramming of the digital processor. Thus, as the technology of target systems improves, not only can the fact of a target being hit be detected and counted but also the quality of that hit ("fatal" or "non-fatal") can be indicated and totaled with pre-programmed differences in score providing a "lethality index" at each target and at each firing position for a lane of targets. Because the reliability and maintainability of cathode ray tube display systems have improved dramatically in the last twenty years, a modern military training facility cannot justify the extreme costs associated with lamps and dials in the complex and expensive hard wired systems.

By virtue of the use of a variable image display unit such as a cathode ray tube for displaying target status information, it is now possible to use the CRT in combination with any CRT-sensitive means (such as a light pencil, touch-sensitive or photodiode array) in order to control the operation of the range at the same time. Although in a preferred embodiment Applicant's computer control system utilizes a separate control tablet to input control information to the computer, Applicant's invention by virtue of the cathode ray tube status indicator and digital processor system can easily incorporate such future improvements.

The present invention is compatible with hit position detecting devices such as that disclosed in U.S. Patent 4,281,241 issued July 28, 1981, to Knight et al entitled "Firing Range" and the subject matter thereof is herein incorporated by reference. Similarly, the present invention is completely compatible with the indication and the implementation of

night effects for a firing range such as disclosed in U.S. Patent 4,203,232 issued May 20, 1980, to Knight et al entitled "Night Effects Simulator", which is herein incorporated by reference. Finally, additional function information can be incorporated in the computer and target sensor through the utilization of hit position and ricochet detection information generated by the devices disclosed in Marksmanship Training Apparatus, U.S. Serial No. 110,471 filed January 8, 1980, by Lindsay C. Knight, also herein incorporated by reference.

Thus, the Applicant's invention is characterized by a high degree of cost effectiveness combined with variable operational capability which is provided by combining a video display unit for displaying target operational conditions with an information processing target range control system.

BRIEF DESCRIPTION OF THE DRAWINGS

The above and other objects of the present invention will become clear in relation to the foregoing specification when taken in conjunction with the followin drawings, wherein:

Figure 1 is a perspective view showing a target range incorporating the present invention;

Figure 2 is a perspective view of a target, target mechanism, hit, hit position, and ricochet detection device utilized with the present invention;

Figure 3 is a block diagram illustrating the interrelationship between the video display unit, the processing means and the individual target mechanisms including the peripheral and interface units required for proper operation;

Figure 4 is a partial view of the layout in a preferred embodiment of the video display unit;

Figure 5 is a preferred control panel layout in accordance with one embodiment to the present invention;

Figure 6 is a block diagram of the field equipment module (FEM) and its interrelationship with the target mechanism and sensor;

Figure 7 is a block diagram of the (SCI) and its interrelationship between the field equipment module and the digital processing means; and

Figure 8 is a logic flow diagram with respect to target range control and status display.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

Referring now more particularly to the drawings wherein like numerals designate similar parts throughout the several views, and more particularly to Figure 1, there is shown a target range incorporating the present invention. Targets 10 are located in firing "lanes" at varying distances from the firing line 12 behind which the marksmen 14 are located. For example, at 50 meters distance the right-hand target is up with the left-hand target down. The targets at 100 and 150 meters are up and targets at 200, 250, and 300 meters are down.

It can be seen that each of the targets in a "bank" (a line of targets parallel to the firing line) are connected to a Field Equipment Module (FEM) 16 for that particular bank. The FEMs for the 50 meters, 100 meters, 150 meters, 200 meters, 250 meters and 300 meters banks are all connected to the digital processing means 18 located in the range control building 20. When situated in said building, a Range Control Officer can monitor the status and control the positioning and response of each target on the range to optimize the beneficial effect of the training sequence. A video display unit (VDU) 22 and a control tablet 24 provide range status/hit information and range function control, respectively. Although this description relates to targets in banks and lanes, the present invention applies to any orientation of targets including a random distribution of targets and to any grouping of targets in the orientation.

Figure 2 illustrates one embodiment of a single target 10 pivotally mounted to be raised and lowered between "up" and "down" positions by target

mechanism 38. A bullet or other projectile having a trajectory 34 strikes the target setting up target vibrations 36 which travel outward away from the impact point of the projectile. The presence of these target vibrations is detected in hit detector 32 which may be an inertia switch or any other device for detecting the presence of certain vibrations. Thus, the target mechanism provides an indication to its respective FEM (when interrogated) that it has been "hit".

In a preferred embodiment, sensors S1-S4 are placed in a protected position below ground level in front of the target. The acoustic shock waves emanating from the passage of a supersonic projectile activates sensors S-1, S-3 and S-4 at different points in time, the difference in time intervals being indicative of the position of the projectile's trajectory with respect to the sensors. Additionally, sensors S-1 and S-2, located substantially parallel with the projectile's trajectory, determine the speed of the projectile and serves to discriminate between ricochet hits on the target and properly aimed "hits" on the target. A more detailed discussion of the position determining means, hit detection means, target raising and lowering mechanism and projectile speed measuring devices can be had in copending U.S. Patent Application Serial No. 110,471 filed January 8, 1980, entitled "Marksmanship Training Apparatus" by Lindsey C. Knight, previously incorporated by reference.

In the present embodiment, a simple limit switch which is closed when the target is "up" provides target position information to the respective FEM. The target position information and "hit" information may be considered target "condition" information which is provided the CPU when the target is interrogated. The target mechanism may include cartridges and/or lights for simulation of "return fire" by the target. It may

also include lighting to silhouette the target or to indicate that the target has been hit. These functions are dependent upon the occurrence of a command signal from the CPU indicative that the target has been hit by a projectile, etc. The occurrence of such a command, causes the target function mechanism to react in the predetermined specified manner.

Figure 3 illustrates the functional interconnection of the target mechanisms and hit detectors with the FEMs and the digital processing means 18. In a preferred embodiment, the digital processing means through the Serial Communication Interface (SCI) 30 therein, interrogates the FEMs sequentially in each bank such that the FEMs provide a sequential output indicative of the target status (up/down) and/or "hit" information generated by the hit detector 32. This information is fed serially into the SCI 30 and from there into Computer Processing Unit (CPU) 40. Desired target status inputs are provided by means of control tablet 24 to the CPU and compared with the actual target status information received from the FEMs. If there is a difference, the FEMs command the appropriate target or bank of targets to move to the control panel indicated status.

The actual status or commanded status of the range can be displayed on the video display unit 22 along with target hit information along with any other data desired. Should a permanent record of the range condition be desired, an optional printer 42 (shown connected by a dotted line) can be energized to provide a hard copy printout of marksmen's names and scores associated therewith. Additionally, to simplify maintenance and fault location, the VOU or printer can also point out defective modules of equipment which can easily be replaced in the unlikely event that a difficulty does arise, thus ensuring a minimum of target range down time.

In Figure 3, the arrows indicate the direction of informational flow and as can be seen, target status commands travel from the control panel to the digital processing means and from there to the FEM and to the selected target mechanism with target position information fed back through the FEM and the digital processing means and displayed on the video display unit. Although in Figure 3 only two FEMs have been shown in a range such as that depicted in Figure 1, six FEMs would be utilized (one is used for both 50 meter targets, i.e., for the "right" target and for the "left" target) with each FEM interrogating and controlling 16 targets.

One key aspect of the present invention is the presentation of range status information on the video display unit by means of a variable image display unit. Such a unit could be a charge coupled device (CCD) or, in a preferred embodiment, a Cathode Ray Tube (CRT). This variable image display unit must have the capability of electronically changing the visual image format of the video display. The term variable image display unit is believed to encompass and describe such a device. In a preferred embodiment, the target mechanism status in one of three modes is displayed: "down"; "up", but drop when "hit"; and "up" whether or not "hit". In addition, under the individual target status representation, an indication is provided of the number of times that target is hit.

Turning to Figure 4, the VDU display format is substantially identical to the target range layout with banks of targets indicated in horizontal rows with their distance from the firing line enumerated in the left-hand margin. Target range lane numbers are set forth at the bottom of each vertical row of targets with a total score for each lane indicated just above

the lane number. Each target is displayed on the VDU in an area of two horizontal cells by four vertical cells. The top two cells indicate target selection in the manual mode by a white down arrow in the first cell as shown in the 50 meter left target of lane 1.

The second two-cell horizontal line indicates the target position "up" or "down" and may also indicate, when the "up" position is selected, whether the target has been requested to "illuminate", and/or "retaliate". In one embodiment, the "up" target indication color is green with a perimeter flahsing from black to a color indicating the functions that the target will provide, for example: illuminate-cyan; retaliate-yellow; and detonate-red. If there is a fault indication in the target (generated when the target is commanded to "up" and yet remains in the "down" position), the target status is indicated as down with a fault indication being given on line 3.

When a faulty target is indicated by the computer, the video display unit in line 3 is indicated as yellow with a perimeter flashing from yellow to black. Without a fault indication, line 3 indicates the function status of the target mechanism when a target is hit. Line 3 will be red if the target mechanism drops the target to the "down" position when hit and will indicate all green if the target "hold" mode is selected (when the target remains in the "up" position regardless of being hit or not).

The bottom line or line 4 is a counter to record individual target scores of from 00 to 99. If the score becomes greater than 99, it can no longer be displayed by the two-digit counter, so a flashing 99 will be displayed until the score is reset to 00.

At the upper portion of the video display unit are sections which indicate range power status, time

and date. Should an automatic mode of operation be selected, the particular program number that the computer procesing unit is utilizing is displayed as well as the length of time necessary to fully complete the automatic program. A progress indication as far as completion of the computer program is concerned is indicated with the step number indicator. Additionally, the run time in hours and minutes and the stopwatch in minutes and seconds provide additional useful information.

Obviously, should it be desirable to display additional general information, it could be displayed at the upper or lower portions of the video display unit. If additional target and/or hit position detection information need be displayed, the number of cells horizontally and/or vertically can be expanded with a more sophisticated monitor to provide room for the required display. Although the present embodiment indicates the status of six banks of targets (the 50 meter targets are considered one bank, even though separate status and score information is provided for "right" and "left" targets and 16 lanes, any number of banks and lanes could be displayed on either one or a plurality of cathode ray tube display systems. Although the present invention utilizes a separate control panel, described hereinafter, it is anticipated that future modifications of the present invention will include utilizing the video display unit CRT as both a control panel and a video display unit by means of a light pencil, a touch-sensitive service covering the display screen or a photodiode/phototransistor array located immediately adjacent the screen. Such a system would have even more flexibility than the present system, but would require additional computer support for the operation thereof.

A preferred embodiment of the present invention utilizes a separate control tablet 24 to provide input information to the central processing unit 40 of

the digital processing means 18. One preferred organization of such a control tablet is shown in Figure 5 and again corresponds generally to the orientation of the targets on the target range. The Target Selection portion 51 of the control tablet comprises push button switches (printed circuit board (PCB) mounted) provided in 16 vertical rows which correspond to the 16 lanes on the target range. Seven horizontal rows are provided which correspond to the seven banks of targets as shown in Figure 1 (again, the 50 meter right and 50 meter left targets are considered the same bank because they are the same distance from the firing line). Any individual target or targets can be singled out for action by pressing the button in the appropriate lane and bank corresponding to the target desired. In other words, pressing the button at the intersection of lane 1 and the 300 meter bank will cause lane 1's 300 meter target to respond to the commanded function. Additionally, an entire bank can be commanded to respond to a given function by pressing the "Bank Common" button for the desired bank shown on the left of the control table as bank common 50. In the event that it is desirable to provide a function to all targets, the "All Targets Button" 52 on the right portion of the target selection panel can be depressed.

After target selection has been accomplished by pressing one or more of the buttons in the target selection portion of the control table, the desired function which is to be commanded to that target must be selected. In the Range Functions portion 54 of the control tablet, there are a number of buttons which will provide a target function command, for example, target "Up" or target "Down". Normally if target up is selected, the target will remain up only until it is hit and then will fall. However, target "Hold" can

be actuated in which case the target remains up until commanded down or until hit after target "Hold" has been deenergized with respect to the selected target.

"Illum on" and "Illum off" relate to the illumination of targets during night firing simulations. "Print Out" will command a remote printer 42 to make a permanent record of the status of the selected target or targets. The "Hit/Burst" button controls whether a target indicates each individual hit or indicates bursts of hits (a plurality of individual hits which are not separated by more than a predetermined length of time are registered as one hit). "Prog. Run" and "Prog. Pause" relate to controlling individual targets or groups of targets by means of an automatic control program which can either be pre-programmed by the control tablet operator or can be established consistent with a predetermined marksmanship training program.

The scores indicated at each target and at each lane can be reset either individually or for the entire range by commanding a target selection and the range function "Reset Score". However, in order to avoid accidental destruction of score information, the reset score must be depressed and followed by depressing the "Yes" button in the Programming portion 56 of the control tablet.

The Operating Mode portion (58) of the control tablet turns the range on and off with the "Range On/Off" switch which, to prevent loss of data, must be operated in conjunction with the "Yes" switch in the Programming portion of the control tablet. The "Manual" button, when operated, permits manual operation

of the targets by means of the "Target Selection" and "Range Functions" portions of the control tablet. The "Auto" switch transfers control of target selection and range function to a stored program in the Digital Processing Means 18 or other storage medium. The "Program Generation" switch, when depressed, permits the control tablet operator to pre-program a sequence of target selection and range function actions over a period of time which can then be utilized in the "Auto" operating mode.

The Programming portion of the tablet includes not only the "yes" and "no" switches but also numbers 0 through 9 and a number of function keys. The "Prog. No" key, when depressed, indicates that the number to follow is either the number of a program being generated (if in the program generation mode) or the program selected (if in the auto operating mode). The "Repeat" key requires that the previous inputted information be repeated. The "Step No" key indicates that the next inputted number is a step number in the program generation mode. The "Clear" button clears any previously inputted tablet button depression information and allows a correction to be made. Depressing the "Time" button in the programming portion of the control tablet indicates that the following number is the length of time that a particular step will take prior to the program moving on to the next step in sequence. The "Interlock" button must be depressed to mark the last digit of any number entered on the numerical key.

Thus, by virtue of the control tablet 24 and the various key groupings thereon, the target range can be advantageously controlled either manually or automatically and the automatic operation can be either a previously prepared program or a program prepared by the control tablet operator in accordance with the wishes of the Range Control Officer or other director of training. Although this particular control tablet is a preferred embodiment, it will be seen that other range functions, operating modes and programming functions could be added if desirable to the system user. As previously noted, the method of target selection could be modified if there were different numbers of lanes and/or banks in a given target range system. Furthermore, an additional horizontal row of buttons could be utilized to activate all targets in a designated lane in much the same manner as the Bank Common buttons select all targets in the designated bank. It is further clear that the control tablet operates and interacts very closely with the information presented on the previously discussed video display unit which displays either the actual status of the range or the commanded status of the range (depending on the user requirement) when operating in the manual or automatic modes and displays the effect of the program being generated when the control tablet is in the program generation mode of operation.

The Field Equipment Modules 16 are shown in more detail in Figure 6 and their interrelationship with the rest of the system can be seen in Figure 3. As has been noted earlier, a separate FEM is provided for each bank or group of targets and handles bidirectional communication between the Serial Communication Interface (SCI) of the digital processing means 18 and the individual target mechanisms. Thus in the right-hand portion of Figure 6, the FEM communicates through multichannel links to the targets associated with that FEM (in the preferred embodiment there would be 16 targets associated with each FEM although greater or lesser numbers of targets could be utilized depending upon the target range involved). At the left most portion of the figure, the bidirectional communication link with the SCI is shown.

Requests for information or function instructions (both of which are considered commands) from the SCI on the bidirectional communication link are inputted to the electrical isolation block 60 and passed on to the receiver 61. The sequencing controller 62 sequences the passing of the received signal and the operation of the serial-to-parallel converter 63 such that parallel pattern is provided through electrical isolation block 64 to the targets. Obviously, the command identifies which target in this bank is concerned and applies the function signal or request for information to that target.

The target mechanism 38 is responsive to command signals from the FEM and causes the target to operate appropriately (up/down, etc.). The target

mechanism in turn provides a parallel signal indicative compliance with the function signal or provides the information (in the case of a request for information) to the electrical isolation block 64 and is subsequently supplied to the parallel-to-serial converter 65. The operation and output of the parallel-to-serial converter 65 is sequenced by sequencing controller 62 such that transmitter 66 outputs a serial word indicative of the command response or information requested from the target through the electrical isolation block 60 to the bidirectional communications link with the SCI.

Thus, each field equipment module is capable of distributing signals from the bidirectional communications link in multiplexed form to the individual target mechanisms and, in the opposite direction, demultiplexing signals from the target mechanisms for transmission back to the SCI. The construction of parallel-to-serial converters, transmitters, receivers, the multiplexers and demultiplexers contained in electrical isolation block 64 would be obvious to those of ordinary skill in the art and would depend, to a large extent, on how information is generated in the target mechanism and how the information is utilized in the central processing unit. Obviously, different computer systems and target mechanisms may require a different FEM. Additionally, if hard wired communication is acceptable (although it has poor reliability and maintainability characteristics), information could be directly inputted in parallel form to the maxibus eliminating the need for the FEM.

The operation of the serial communications interface (SCI) is more clearly shown in Figure 7. The SCI is a computer peripheral device which correctly supplies information in the appropriate format to and from the CPU. The block diagram in Figure 7 indicates the functional blocks necessary in order to condition information from the bidirectional communication link such that it is usable on the maxibus of the CPU utilized in the present invention (the Computer Automation, Inc. Mini 4/90). The information flow is relatively straightforward with the command and/or request for information being generated in the CPU and applied in parallel form to the maxibus. The maxibus information is converted to serial form in the parallel-to-serial converter 90 and applied through transmitter 91 to the electrical isolation block 92. The isolation block applies the command or request for information to the bidirectional communications link which supplies the information to all FEMs, only one of which responds to the applied signal as noted above.

The returning serial signal from the FEM on the bidirectional communication link is applied to the electrical isolation block 92 and from there to receiver 93. The operation of transmitter 91 and receiver 93 is controlled time-wise by timing control 94. The output of receiver 93 is forwarded to serial-to-parallel converter 94 and the function response or requested information is supplied to the maxibus in parallel form and from there to RAM and magnetic storage and/or the CPU. Thus, the CPU can transfer the status of data bus lines (a data bus line is a portion of the maxibus) in a selective manner to the FEMs and, for

for information moving in the opposite direction, the CPU can sense the status of multiplexed control lines as they arrive from the target mechanisms to the FEMs.

By way of example, the following data and command exchange will facilitate a more complete understanding of command and status information transfer in this invention. This sequence is utilized to provide the "target up" function. Again it is stressed that the actual bit patterns which follow are almost totally independent of the hardware used and could be changed to suit a variety of different software and hardware. Further, it should be noted that all bit patterns are expressed in the hexadecimal system.

ADDRESS	8801	sent from CPU to FEM (specific to FEM No. 1)
ADDRESS	8801	sent from FEM to CPU acknowledging selection (of FEM No. 1)
COMMAND	A1E0	sent from CPU TO FEM announcing that a single word that follows concerns outputting to mechanism control lines
DATA	D002	sent from CPU TO FEM; this bit pattern will activate "up" control line to FEM No. 1 target mechanism No. 1

Note that after the ADDRESS Response from FEM No. 1, the COMMAND and DATA "words" are received by all FEMs but only FEM No. 1 will respond.

A sequence to send the same target a "down" control is as follows:

ADDRESS	8801
ADDRESS	8801
COMMAND	A1E0
DATA	D001

A sequence to extract hit and up indication data from a different FEM is as follows:

ADDRESS	8802	sent from CPU to FEM No. 2
ADDRESS	8802	sent from FEM No. 2 to CPU
COMMMAND	A2E0	sent from CPU to FEMs, announcing that CPU expects one word of status from FEM No. 2
DATA	B201	sent from FEM to CPU, stating that target No. 1 connected to FEM No. 2 is in the up position and has been hit

The logic utilized with reference to the above communication exchange sequences will be clear to one of ordinary skill in the art in view of the hardware utilized in the present invention. Different "languages" and/or sequences can be used if different software or hardware is used or if different information is to be queried and/or generated. Therefore, the above description is believed to be exemplary of one embodiment in the present invention and not to be a limitation upon the scope of this invention.

A flow diagram indicating the logic flow of information between the range and the computer and video display unit is shown in Figure 8. The main logic flow components comprise two tables, the Target New Table 70 and the Target Now Table 72. The Target New Table contains the desired range configuration and can be changed by information from the range or information from a range control system, which may be either manually or program controlled. The Target Now Table contains information as to the actual condition existing at a target (primarily up/down information). Obviously, when a target is up but has been commanded down, the Target New Table will have the down command allocated for that target but until the target has actually moved to the down position, the Target Now Table will indicate that the target is still up.

The manual inputs to the Target New Table are provided by control inputs from control tablet 24 in a preferred embodiment which provides not only target selection information from the target selection portion of the tablet, but also function selection information. When the function selection table is accessed by the control input, it provides the selected function information after the target selection information in a code which is supplied to the Target New Table. The table for the target and function selected is adjusted to reflect any change in function for that target which has been keyed into the tablet.

As previously discussed, in the automatic operating mode, range status control signals can be provided by a stored program which will identify the appropriate targets and functions in a desired sequence.

Furthermore, when certain functions such as "retaliate" and/or "detonate" and/or "drop target when hit" are designated, the Target New Table responds to "hit" information from the range. This information similarly is in the form of a code word identifying the target which has been hit and assuming that the manual or programmed range status controller has enabled the range to "retaliate", "detonate" and/or "drop target when hit", the occurrence of a hit will energize the desired function command in the Target New Table 70. Converter 74 serves to convey the target selection information and the desired function change information to a form usable by the range which is then sent out serially in well-known fashion. The status of the Target New Table is provided to a range status information block 76 which converts the information to a form compatible with the video display unit 22.

The "hit" information from the range is also accumulated in the individual target score block 78 and is also added to determine target score for each lane in the add target box 80. Individual target scores and lane total scores are provided to video display unit 22 in a conventional manner.

"Status" information from the range regarding each target is supplied to the Target Now Table 72 and compared in the range status information block 76. Where a discrepancy is maintained between Target New Table 70 and Target Now Table 72 for more than the required transition period of a target from an up position to a down position, the range status information

block 76 will provide a fault indication to video display unit 22.

As alluded to earlier, the present invention is a combined target range status indicator and controller which, in the preferred embodiment, utilizes one cathode ray tube to provide target status information as well as "hit" and scoring information. It is obvious that other variable image display devices could be used and that numerous modifications to the specific logic and hardware utilized in this invention can be supplied by those of ordinary skill in the computer art in view of the above disclosure depending upon the specific requirements of the user of the invention. For example, instead of the video display unit utilizing the target status command signal as an indication of the target status, it could just as easily respond to the range generated target status information. Hit position information as well as descrimination between ricochet hits and actual hits can be incorporated into the target scoring and the video display unit to provide an index of lethality as feedback provided each marksman during use of the target range.

In a preferred embodiment of the present invention, the computer processing unit (CPU) was made by Computer Automation, Inc., at Irvin, California, which is designated Model 4/90. The video display unit comprises any standard 19-inch color monitor having 48 lines with 80 characters per line and in this instance was an ISC Graphic 8001 GB with accessories, manufactured by Intelligent Systems Corporation, 5965 Peach Tree Circle E, Norcross, GA. The up sensor in a

preferred embodiment comprises a limit switch with positive logic, but negative logic could be utilized with very slight reprogramming. The hit detector in a preferred embodiment is the "inertial switch" as described in the aforementioned Knight Patent. The computer processing unit may be programmed as required depending upon the precise computer or video display unit, sensor logic, hit detector or target layout. These source listings are believed to be in the purview of one of ordinary skill in the art in view of the above disclosure. Although the processing means has been discussed with respect to a digital embodiment, analog or hybrid systems could be adapted for use in this system in view of the present disclosure.

The foregoing description and disclosure of the invention is illustrative and explanatory thereof, and various modifications and improvements may be made by those skilled in the art within the scope of the appended claims without departing from the present invention.

WHAT IS CLAIMED IS:

1. A target range status indicator for target range having a plurality of targets (10) arranged in at least one lane, said range status indicator comprising:

a plurality of target condition sensor means (16, 32), each responsive to a respective target, for providing an output indicative of at least one condition of said respective target;

processing means (24, 40), responsive to said sensor means output, for providing output signals indicative of the status of conditions of said plurality of targets (10); and

video display unit means (22), responsive to said processing means output signals, for displaying said conditions of said target, said video display unit comprising at least one variable image display unit.

2. A range status indicator in accordance with claim 1, wherein said target range comprises a plurality of lanes adjacent one another with a plurality of targets (10) in each lane, said target in adjacent lanes forming banks of targets, said variable image display unit (22) providing a visual representation, in a format generally equivalent to said banks and lanes of targets, of said condition of said target.

3. A range status indicator in accordance with claim 1, wherein said condition is a target position condition.

4. A range status indicator in accordance with claim 1, wherein said condition is a target hit condition.

5. A range status indicator in accordance with claim 1, wherein said conditionis a target function status indication.

6. A range status indicator in accordance with claim 1, wherein each of said sensor means (32) is a hit detection sensor comprising:

means (32) for detecting said target being hit by a projectile; and

means (18), responsive to said detecting means, for providing an output signal indicative of said hit detection for a period of time until interrogated.

7. A range status indicator in accordance with claim 6, wherein said processing means comprises:

interrogation means for interrogating each of said output providing means (18), for resetting said output providing means, and for providing a serial output signal indicative of said plurality of output providing means condition prior to said reset; and

means for providing said digital processing means (18) output signals indicating a hit on targets whose latching means indicates a hit when interrogated.

8. A target range status indicator and controller for a target range having a plurality of targets (10) arranged in at least one lane, said indicator and controller comprising:

a plurality of target function mechanism means (38), at least one for each target, for enabling said target to function in a predetermined manner in response to a command;

a plurality of target condition sensor means (32), each responsive to a respective one of said targets, for providing an output indicative of at least one condition of said respective said target, said condition comprising said target being hit with a projectile or the functional status of said target function mechanism;

means for displaying information and for controlling said target function mechanism means, said displaying and controlling means comprising:

computer processing unit (40) (CPU) means, responsive to said sensor means, for providing a video signal output indicative of said at least one condition;

means (24) for inputting target selection and functional commands to said CPU means, said CPU means including means, in response to a target selection and functional command, for sending a command to a selected target sensor means (32) in order to enable said respective function mechanism means to function in said predetermined manner; and

video display unit (VDU) means (22), responsive

to said video signal output, for displaying said condition of said selected target, said VDU means comprising at least one variable display means.

9. The target range status indicator and controller in accordance with claim 8, wherein

said inputting means (24) command comprises a raise/lower command to a selected target;

said target function mechanism (38) includes a means, responsive to a raise /lower command, for moving said selected target to a raised and lowered position, respectively;

said target condition sensor means output is at least indicative of the raised/lowered position of said target;

said CPU (40), responsive to said raised/lowered indicative output, provides a raised/lowered video output to said VDU (22); and

said VDU providing a visual indication of said selected target raised/lowered position on said variable image display means.

10. The target range status indicator and controller in accordance with claim 8 or claim 9, wherein:

said sensor means comprises a hit detection means (32) for providing a hit condition signal when a target is hit by a projectile;

said CPU (40) including means for interrogating said sensor means and, upon detecting said hit condition signal from a target, for providing a video hit condition

signal identifying which of said targets has been hit; and

said VDU (22), responsive to said video hit condition signal, displaying said hit information with respect to the target identification on said variable image display means.

11. The target range status indicator and controller in accordance with claim 10, wherein:

said inputting means (24), comprises means providing a "drop when hit" command to said CPU (40) with respect to an operator selected target; and

said CPU (40) further comprises means, responsive to said target hit condition, for generating and transmitting a "lower target" command signal to said function mechanism means associated with said selected target when said "drop when hit" command has been supplied with respect to said selected target.

12. A target range status indicator and controller for a target range having a plurality of target lanes, each lane having a plurality of targets (10), at least one target in each lane being further from a firing line (12) than other targets in said lane, targets in adjacent lanes forming at least two banks of targets, each bank substantially parallel with said firing line (12), said indicator and controller comprising:

a plurality of target function mechanism means (38), one associated with each of said targets (10), for enabling

said target to respond in a predetermined manner to a command;

a plurality of target condition sensor means (32), one associated with each of said targets, for providing an output indicative of a status of said target (10) when interrogated, said status comprising at least one of said target being hit with a projectile, said target in an "up" position, and said target in a "down" position;

a plurality of field equipment module (FEM) (16) means, each associated with all targets in a bank, for interrogating and commanding said sensor means and said function mechanism means, respectively, in one of said banks in response to receiving a status request/command, which addresses said one of said banks, said FEM means (16) further providing a status report in response to a status request;

means (22) for displaying information and controlling said function mechanism means comprising:

processing means (18) including a computer processing unit (CPU) means (40), responsive to input signals, for providing a status request/command to the FEM means (16) associated with the bank of a selected target, said input signals identifying the selected target (10), said status request/command including an address for enabling the FEM means (16) associated with said selected target, said address further identifying the selected target (10) in the plurality of targets associated with said enabled FEM means (16), said CPU means further, responsive to a status report from said FEM means (16), providing a video

signal output indicative of said status of said selected targets;

means (24) for providing input signals to said CPU means, said input signals identifiying at least said selected target and a function command to be sent to said selected target; and

video display unit (VDU) means (22), responsive to said video signal output, for visually displaying the status of said target on at least one variable image display unit.

13. The target range status indicator and controller in accordance with claim 12, wherein said processing means is a digital processing means (18) which comprises:

serial communication interface (SCI) (30) means for converting parallel form status requests/commands in said CPU into transmittable serial form status requests/commands and for converting received serial form status requests/commands into parallel form for said CPU; and

bidirectional communication means for serially transmitting and receiving serial form status requests/commands between said SCI means and said FEM means.

14. The target range status indicator and controller in accordance with claim 13, wherein said FEM (16) includes means (63) for converting said serial form status requests/commands into parallel form, said FEM (16) converting means further applying said parallel form status requests/

commands to said plurality of target function mechanism means (38) and said target condition sensor means (32).

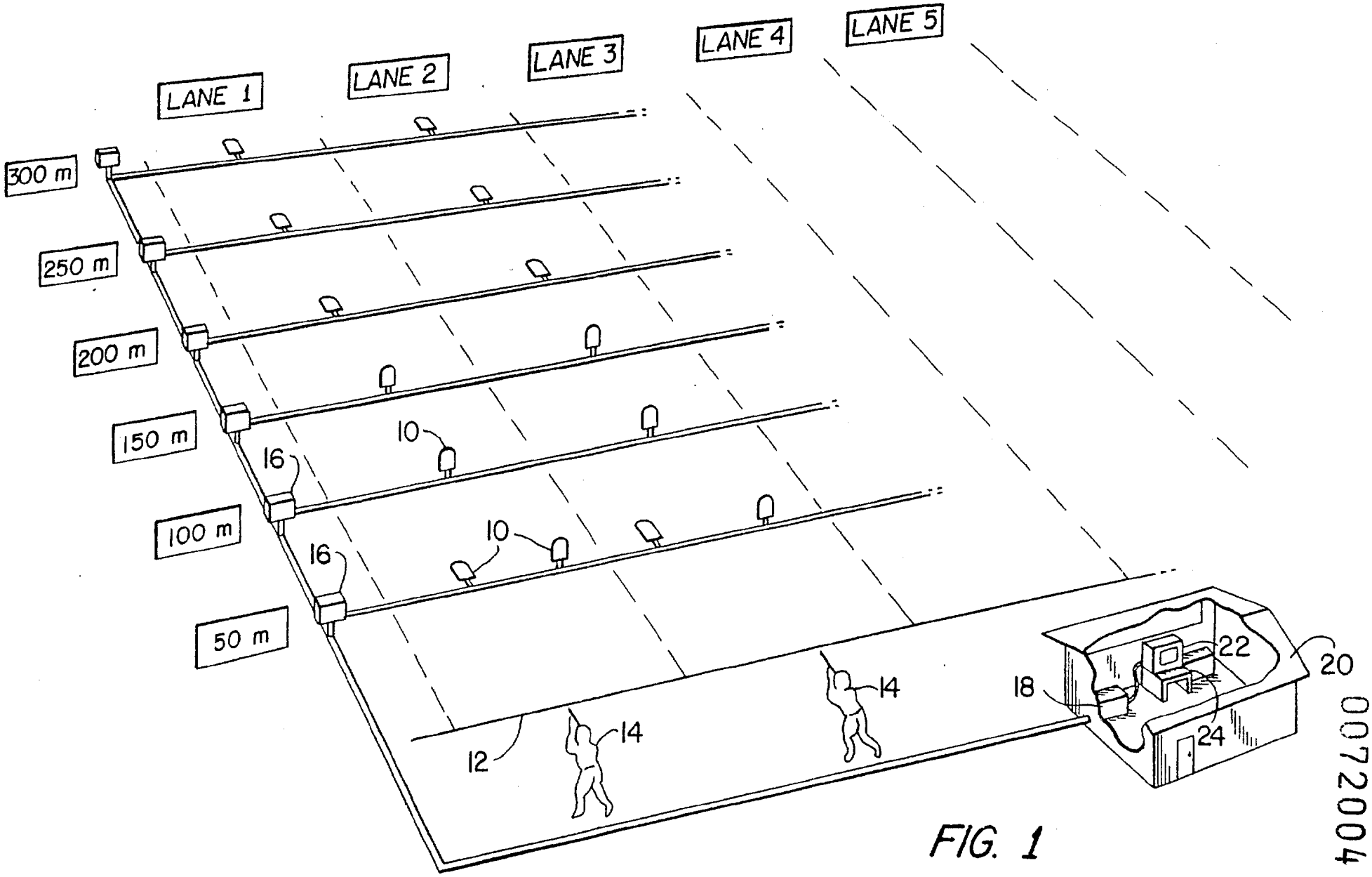


FIG. 1

ANGE POWER OFF
ME HH:11 DATE DD/MM/YY

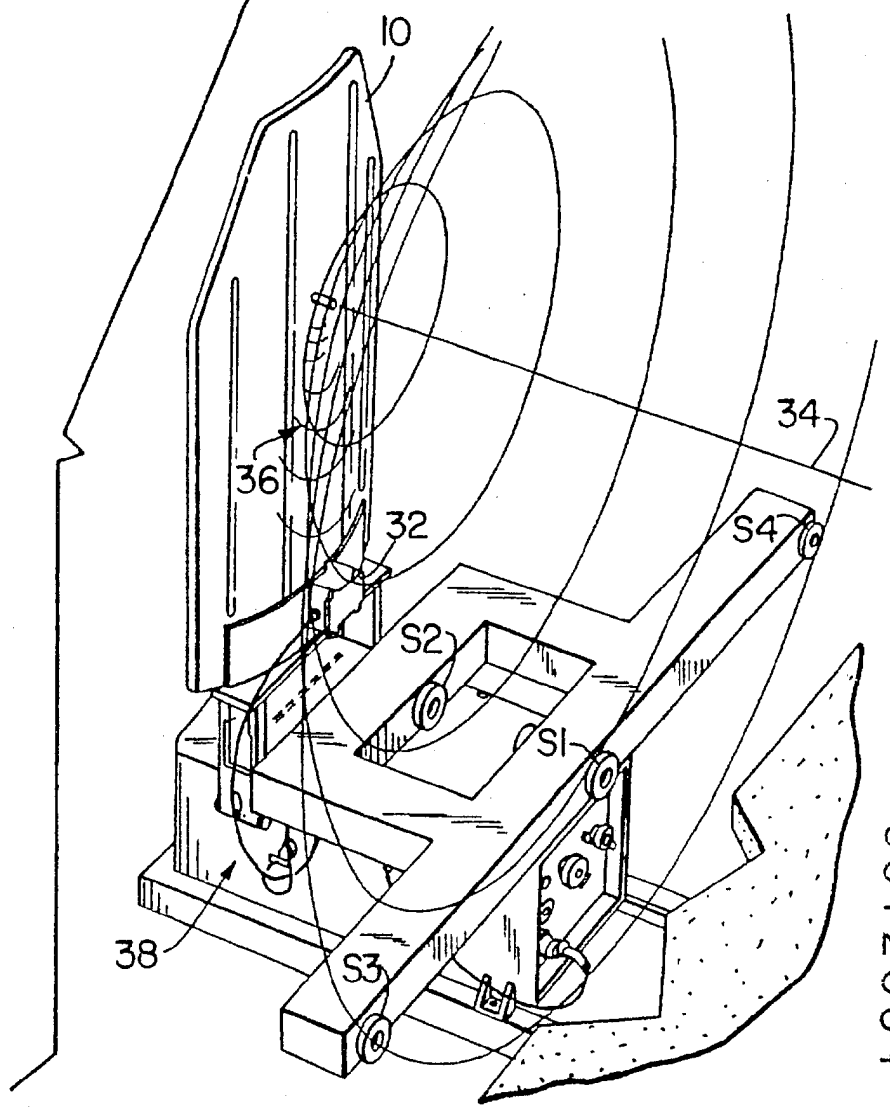
AUTOMATIC MODE
PROGRAM NO____
LENGTH 00:00
STEP NO_____

RUN TIME 00:00
STOP WATCH 00:00

300m					
250m					
200m					
150m					
100m					
50m RIGHT					
50m LEFT					
LANE SCORE TOTAL	00	00			
LANE NUMBER	1	2	3	4	5

FIG. 4

FIG. 2



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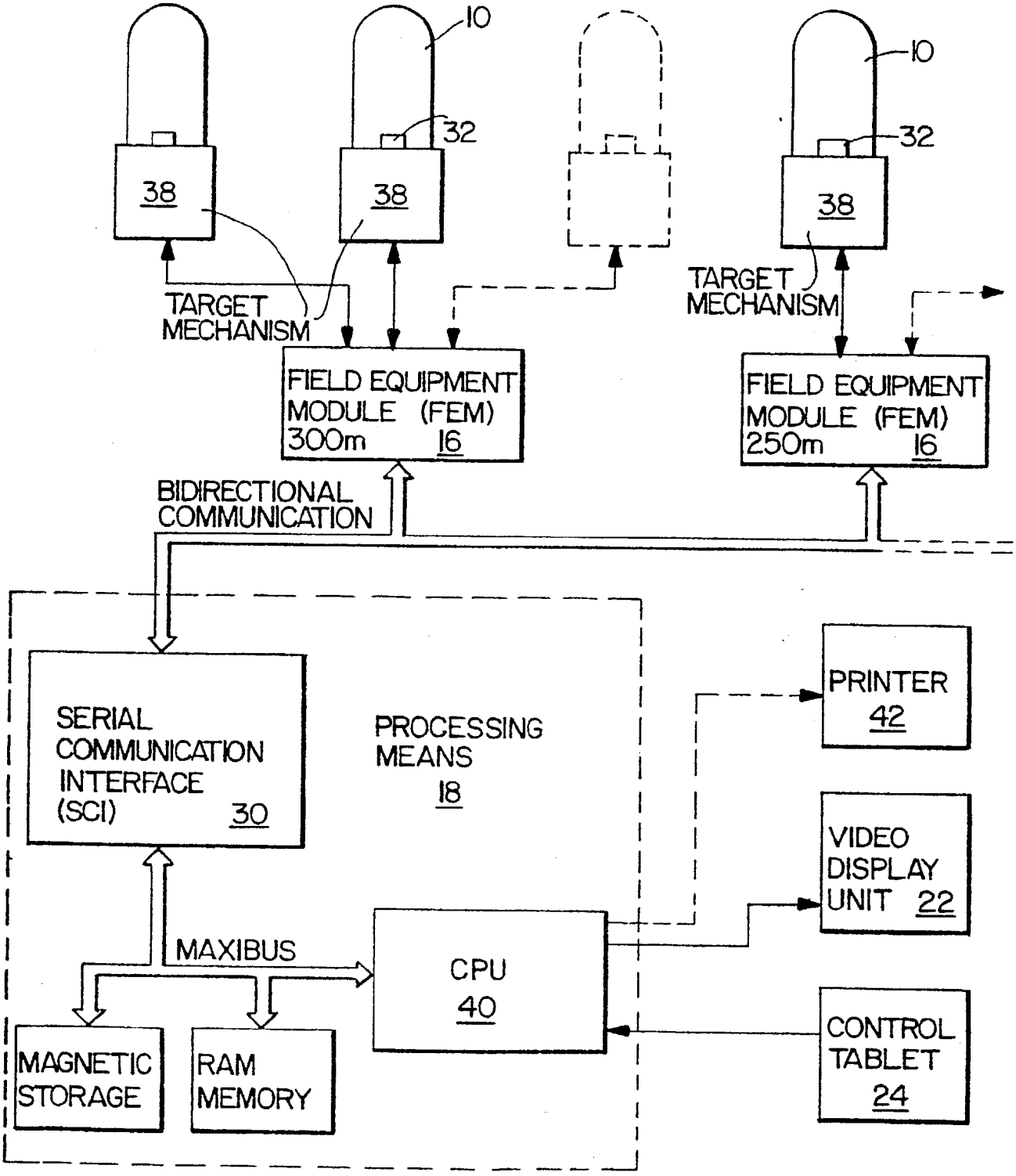
10
32
38
38
10
32
38
TARGET MECHANISM
TARGET MECHANISM
FIELD EQUIPMENT MODULE (FEM) 300m 16
FIELD EQUIPMENT MODULE (FEM) 250m 16
BIDIRECTIONAL COMMUNICATION
SERIAL COMMUNICATION INTERFACE (SCI) 30
PROCESSING MEANS 18
PRINTER 42
VIDEO DISPLAY UNIT 22
MAXIBUS
CPU 40
CONTROL TABLET 24
MAGNETIC STORAGE
RAM MEMORY

FIG. 3

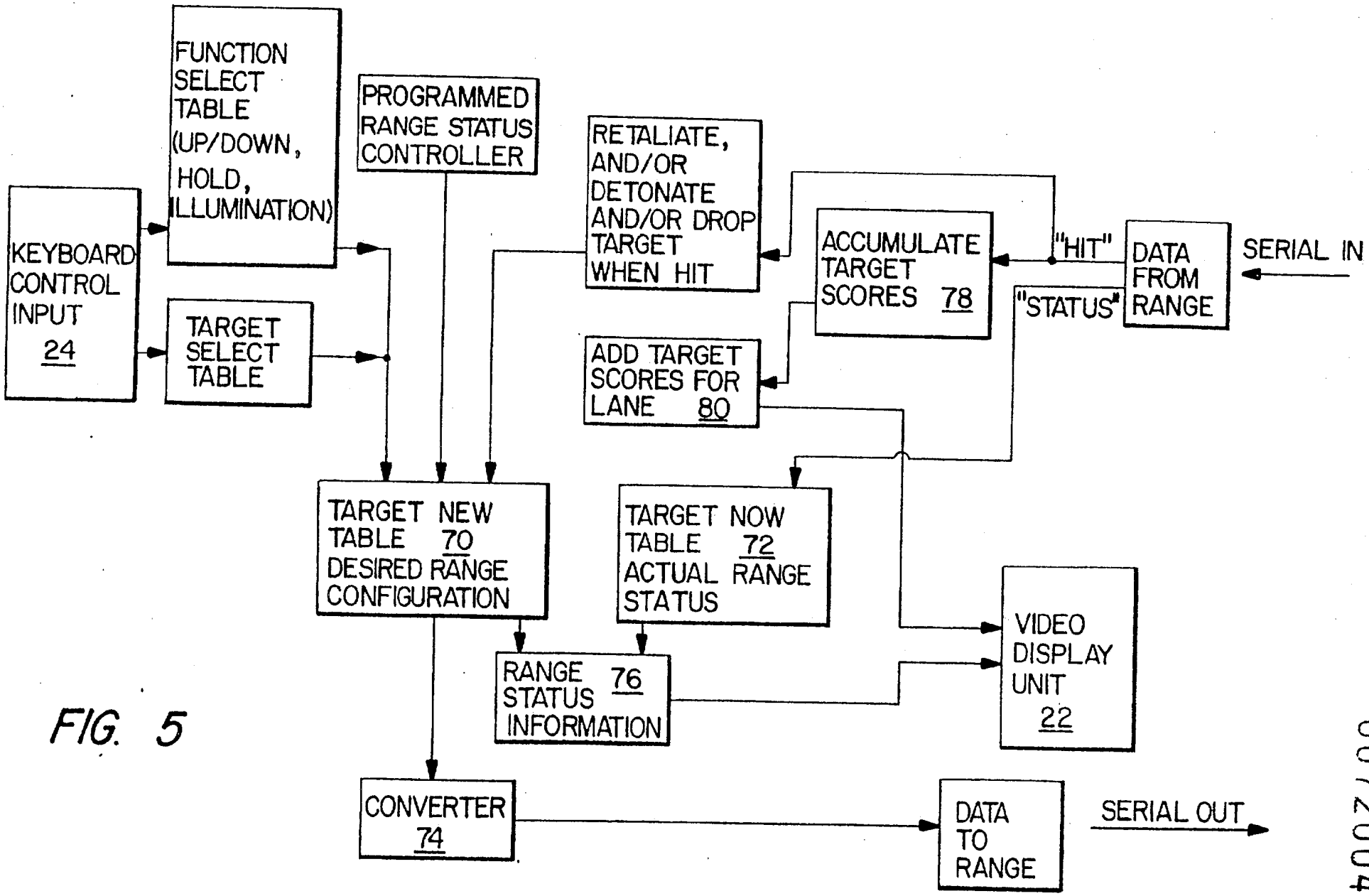

FIG. 5

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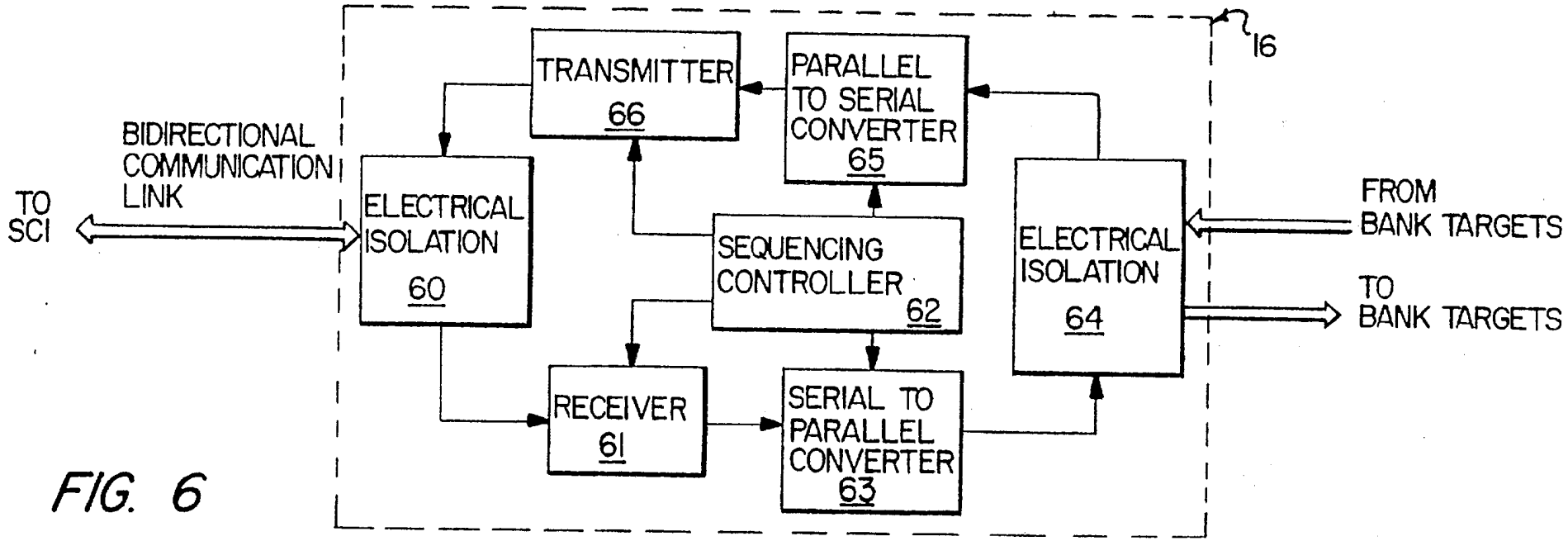

FIG. 6

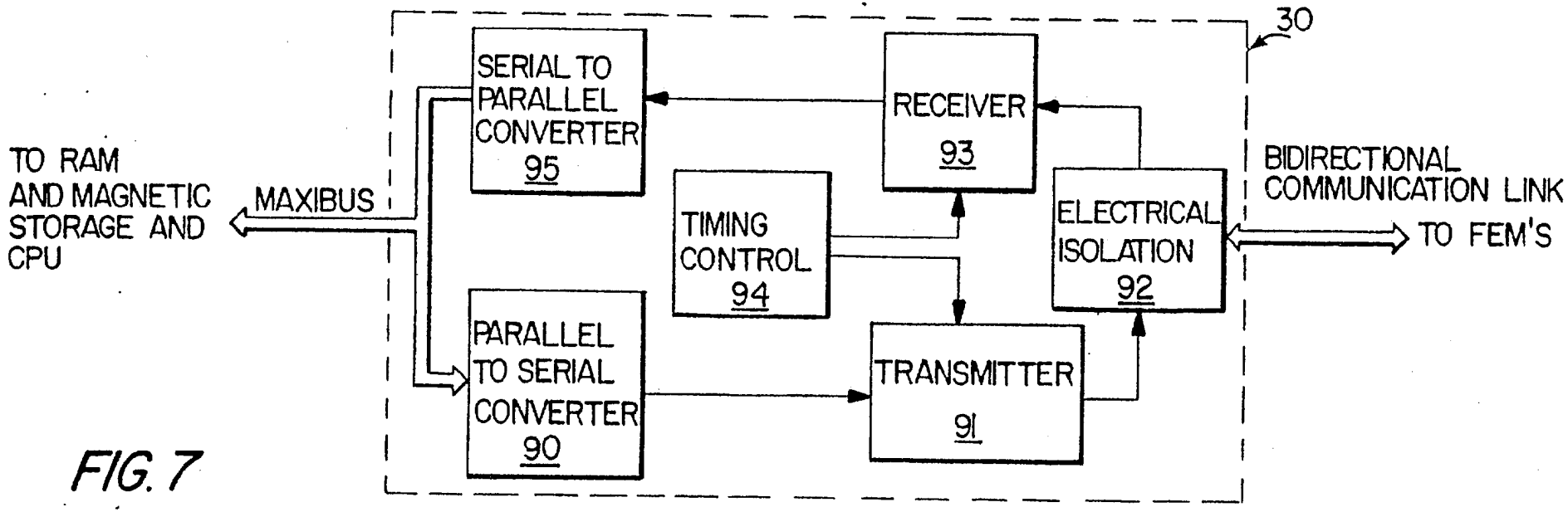

FIG. 7

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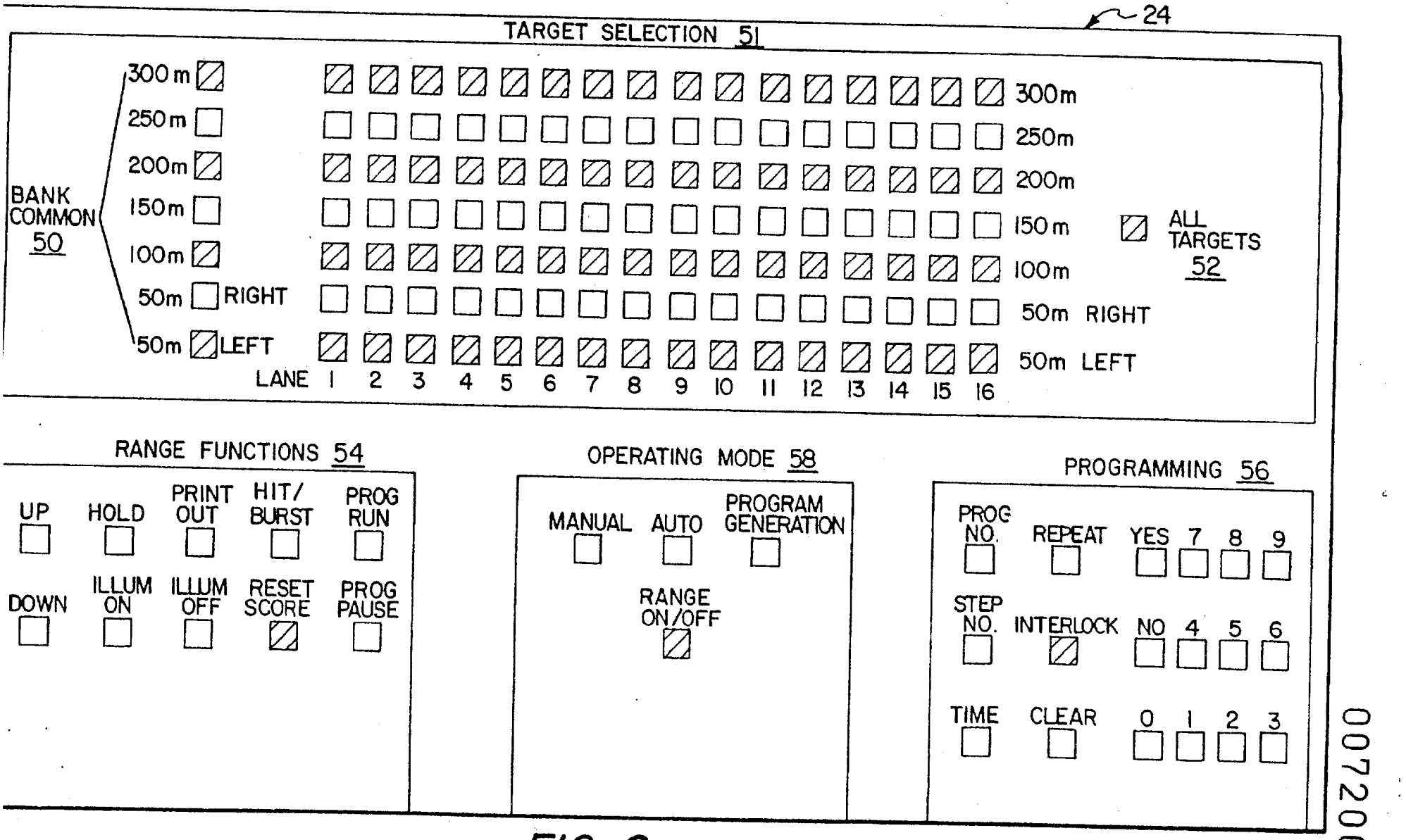

FIG. 8

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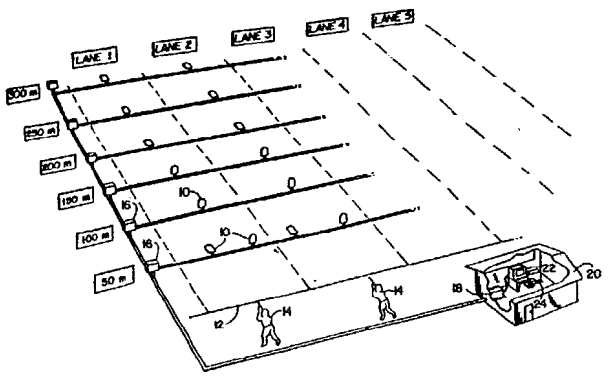
(54) Target range status indicator and controller.

(57) Disclosed is an apparatus for indicating on a video display unit (22) the status of a plurality of targets (10) on a target range system and for controlling the operation thereof. In a preferred embodiment, the video display unit (22) comprises a variable image display unit which can be a cathode ray tube (CRT) which is responsive to a computer processing unit (CPU) (40) which sequentially and periodically interrogates each target mechanism (38) to determine its functional status and whether it has been "hit". This information can be displayed in many different formats although in a preferred embodiment, a number of banks and lanes of targets are provided on the CRT which correspond to the banks and lanes of targets as laid out on the range. Further, the total hits for all targets in each lane are displayed on the screen along with a fault indication if necessary. Substantial improvements and the reliability and maintainability of target range control systems are achieved by the use of the CRT-equipped video display unit (22) in combination with the CPU (40). In further preferred embodiments, all targets in an individual bank provide information to a field equipment module (FEM) (16) for that bank which then provides the information to a computer peripheral device (30) which converts the information to a form usable by the CPU. Additionally, the range may be controlled in a manual, automatic or semi-automatic mode and target status information along with lane scores provided in a permanent manner by means of a peripheral printer (42).



EP 0 072 004 A3

European Patent Office

EUROPEAN SEARCH REPORT

0072004
Application number

EP 82 10 7145

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl. ³)
X	FR-A-2 445 944 (AUSTRALASIAN TRAINING AIDS LIMITED) * Page 8, lines 24-34; page 9, lines 1-31; figures 1,2 *	1	F 41 J 5/00
A	DE-A-2 748 993 (DIETHER HAINA) * Claim 3; figure 1 *		
A,D	US-A-4 203 232 (AUSTRALASIAN TRAINING AIDS LIMITED)		
A,D	US-A-4 222 564 (ALLEN et al.)		
A,D	US-A-4 281 241 (AUSTRALASIAN TRAINING AIDS LIMITED)		

TECHNICAL FIELDS SEARCHED (Int. Cl. ³)

F 41 J
F 41 G

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	04-02-1983	WETZEL H.

CATEGORY OF CITED DOCUMENTS

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